WHAT IS CLAIMED IS:

1. A method for applying a coating to a surface of an electrode, comprising the steps of:

(a) placing the electrode in an aqueous solution of ethylenedioxythiophene monomer; and

(b) subjecting the electrode to an electric current such that a polyethylenedioxythiophene polymer coating is formed on said surface.

2. The method of claim 1, wherein said aqueous solution comprises an aqueous solution of a doped ethylenedioxythiophene monomer and a cosolvent.

3. The method of claim 2, wherein said aqueous solution comprises about 0.25% by weight to about 5.0% by weight of said ethylenedioxythiophene monomer.

4. The method of claim 2, wherein said aqueous solution comprises about 0.25% by weight to about 5.0% by weight of said dopant.

5. The method of claim 2, wherein said dopant is a sulfate-containing compound selected from the group consisting of ammonium persulfate, ammonium sulfate, naphthalene sulfate and lithium sulfate.

6. The method of claim 2, wherein said dopant is a tetrafluoroborate salt.

7. The method of claim 6, wherein said dopant is selected from the group consisting tetramethyl tetrafluoroborate, tetraethyl tetrafluoroborate, tetrapropyl tetrafluoroborate, tetrabutyl tetrafluoroborate and mixtures thereof.

8. The method of claim 2, wherein said dopant is selected from the group consisting of p-toluenesulfonic acid and its salts.

9. The method of claim 2, wherein said dopant is an electrolyte salt selected from the group consisting of lithium perchlorate, lithium trifluoromethanesulfonate, lithium hexafluoroarsenate, lithium hexafluorophosphate, phosphoric acid and its salts, phosphorous acid and its salts, and hypophosphorous acid and its salts.

10. The method of claim 2, wherein said cosolvent is selected from the group consisting of methanol, ethanol, 1-propanol, 2-propanol, acetonitrile, ethylene glycol, 1,2-propanediol, 1,3-propanediol, 2-methyl-1,3-propanediol.

11. The method of claim 2, wherein said aqueous solution comprises about 1.0% by weight to about 40.0% by weight of said cosolvent.

12. The method of claim 2, wherein said aqueous solution further comprises an oxidizer.

13. The method of claim 12, wherein said aqueous solution comprises about 1.0% by weight to about 5.0% by weight of said oxidizer.

14. The method of claim 12, wherein said oxidizer is an organic acid.

15. The method of claim 14, wherein said oxidizer is a dicarboxylic acid.

16. The method of claim 15, wherein said oxidizer is selected from the group consisting of oxalic acid, maleic acid, suberic acid, azelaic acid and sebacic acid.

17. The method of claim 14, wherein said oxidizer is a hydroxy acid.

18. The method of claim 17, wherein said oxidizer is malic acid.

19. The method of claim 17, wherein said oxidizer is citric acid.

20. The method of claim 2, wherein said aqueous solution further comprises a surfactant.

21. The method of claim 20, wherein said aqueous solution comprises about 0.01% by weight to about 0.5% by weight of said surfactant.

22. The method of claim 20, wherein said surfactant is dioctyl sulfosuccinate.

23. The method of claim 1, wherein said current is a direct current with a current density of about 0.05 mA/cm^2 to about 5.0 mA/cm^2.

24. The method of claim 1, wherein said current is applied for about 1 minute to about 60 minutes.

25. The method of claim 1, wherein said current is a direct current with a current density of about 0.25 mA/cm^2 applied for 2 minutes, followed by a direct current with a current density of about 0.5 mA/cm^2 applied for 7 minutes, followed by a direct current with a current density of about 0.25 mA/cm^2 applied for 1 minute.

26. The method according to claim 1, further comprising the step of:

(c) prior to step (a), cleaning the surface of the electrode.

27. The method of claim 26, wherein said cleaning step is a chemical etch process.

28. The method of claim 1, wherein the electrode is composed of a material selected from a group consisting of titanium, niobium, tantalum, magnesium, nickel, zirconium, zinc, platinum, silver, gold and aluminum.

29. The method of claim 1, wherein said electrode is subjected to said current in said aqueous solution for multiple iterations in order to further enhance the surface area of said electrode.

30. An electrode having a surface to which a polyethylenedioxythiophene polymer coating is applied according to the method of claim 1.

31. An electrolytic capacitor comprising a cathode electrode having a surface to which a polyethylenedioxythiophene polymer coating is applied according to the method of claim 1.

32. An implantable cardiac defibrillator (ICD) comprising an electrolytic capacitor with a cathode electrode having a surface to which a polyethylenedioxythiophene polymer coating is applied according to the method of claim 1.

33. The method of claim 1, wherein said coating enhances the surface area of said electrode.

34. An electrode having a surface to which a polyethylenedioxythiophene polymer coating is applied.

35. The electrode of claim 34, wherein said electrode has a capacitance of at least 350 $\mu F/cm^2$.

36. The electrode of claim 34, wherein said electrode is a cathode electrode of an electrolytic capacitor.

37. The electrode of claim 34, wherein said coating enhances the surface area of said electrode.